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(54) **EXPENABLE/RECOVERABLE VOICE AND DATA COMMUNICATIONS SYSTEM BUOY**

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(52) **U.S. Cl.** **367/134**; 367/2; 367/3
(58) **Field of Search** 367/134, 2, 3

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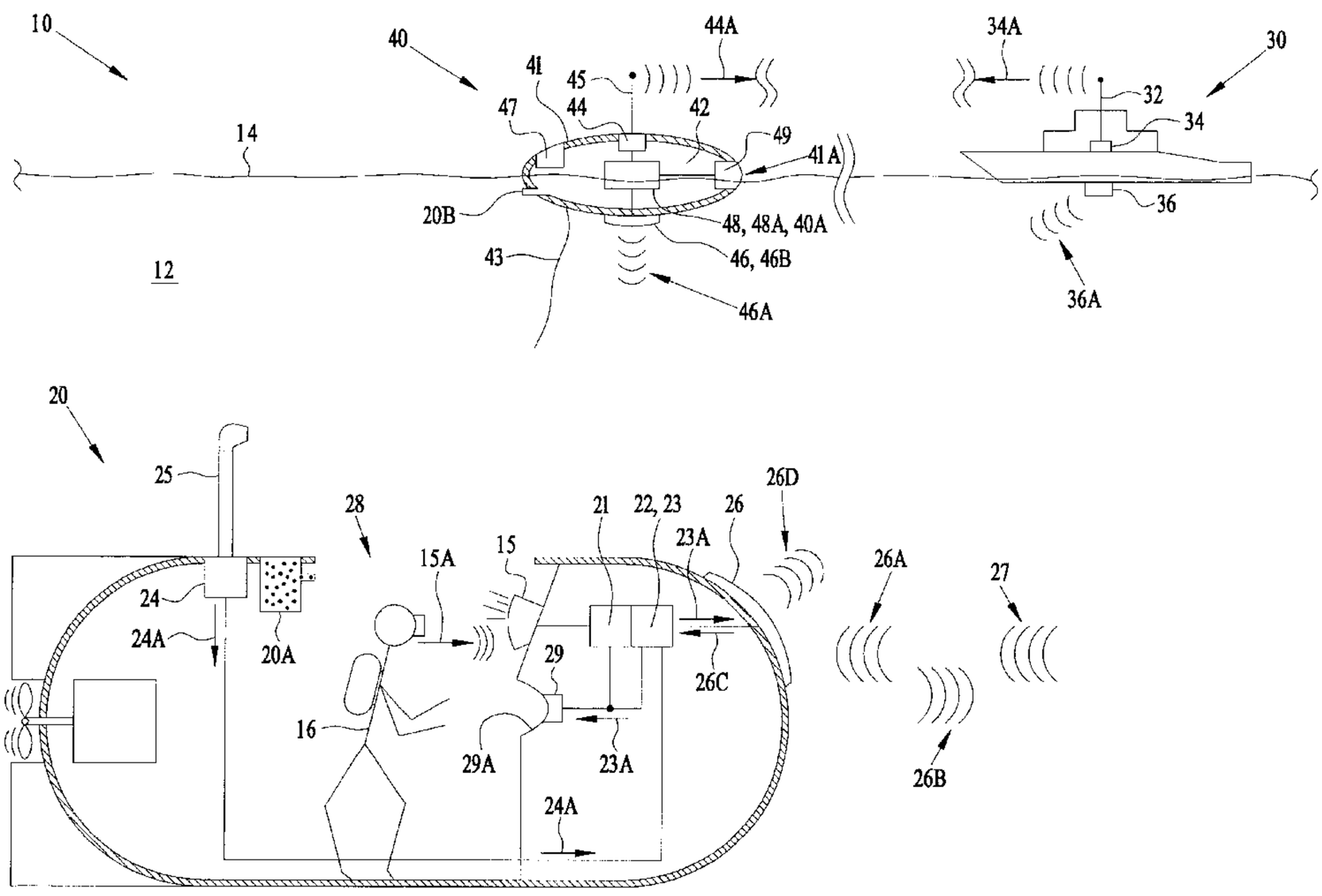
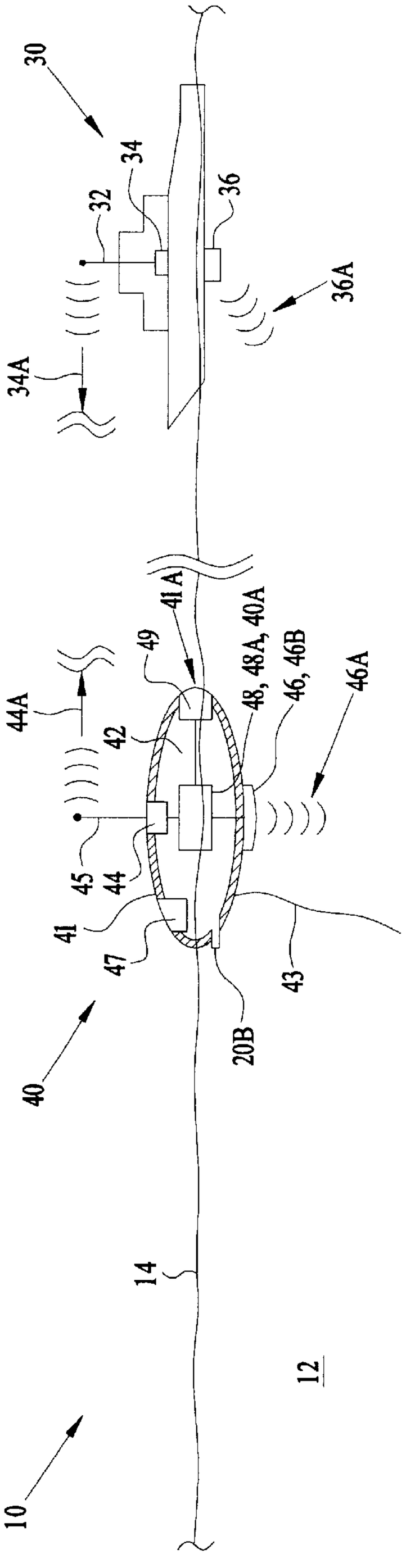
(57) **ABSTRACT**

An untethered communications buoy system has an untethered buoy freely floating on the surface of water to not compromise the location of the submersible. The submersible has a cavity containing a first data interface member connected to a computer/data-storage that is connected to an acoustic transducer. The untethered buoy has a computer/memory module connected to a radio transceiver and acoustic transceiver. A second data interface member is connected to the computer/memory module and is mounted on the untethered buoy for fitting into the cavity and mating with the first data interface member. A ship is remotely located from the submersible and buoy and has a radio transceiver and an acoustic transceiver. Mating the first and second data interface members permits bidirectional downloading of data between the computer/data-storage and the computer/memory module.

14 Claims, 2 Drawing Sheets

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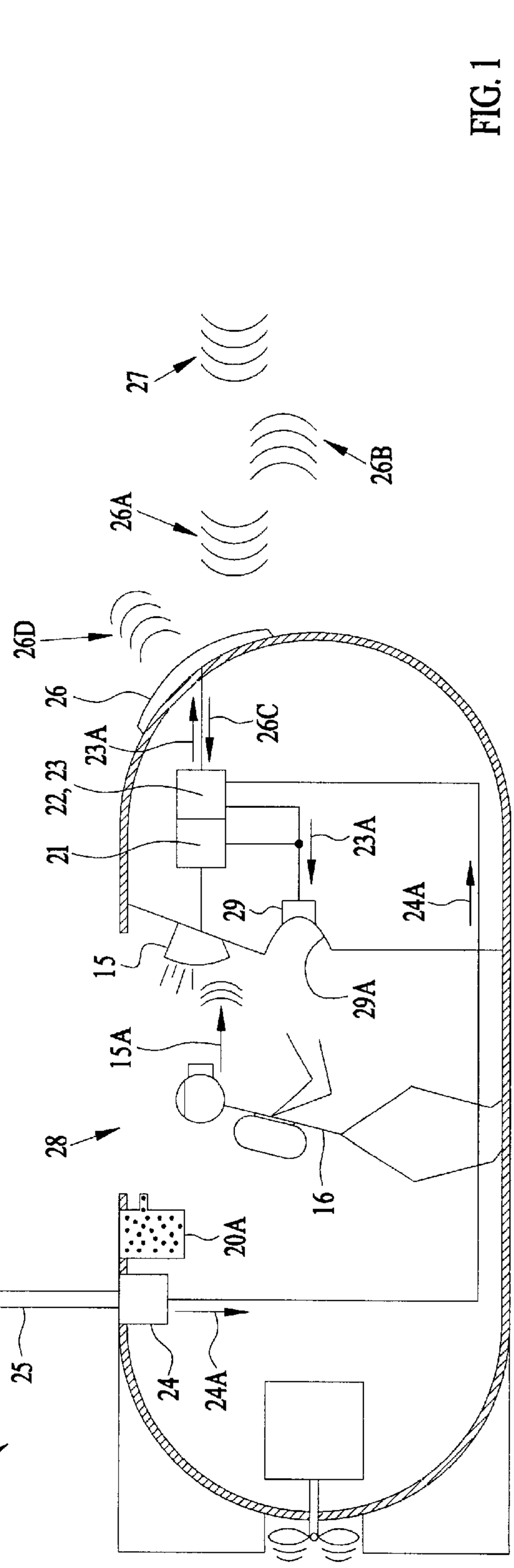
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FIG. 1

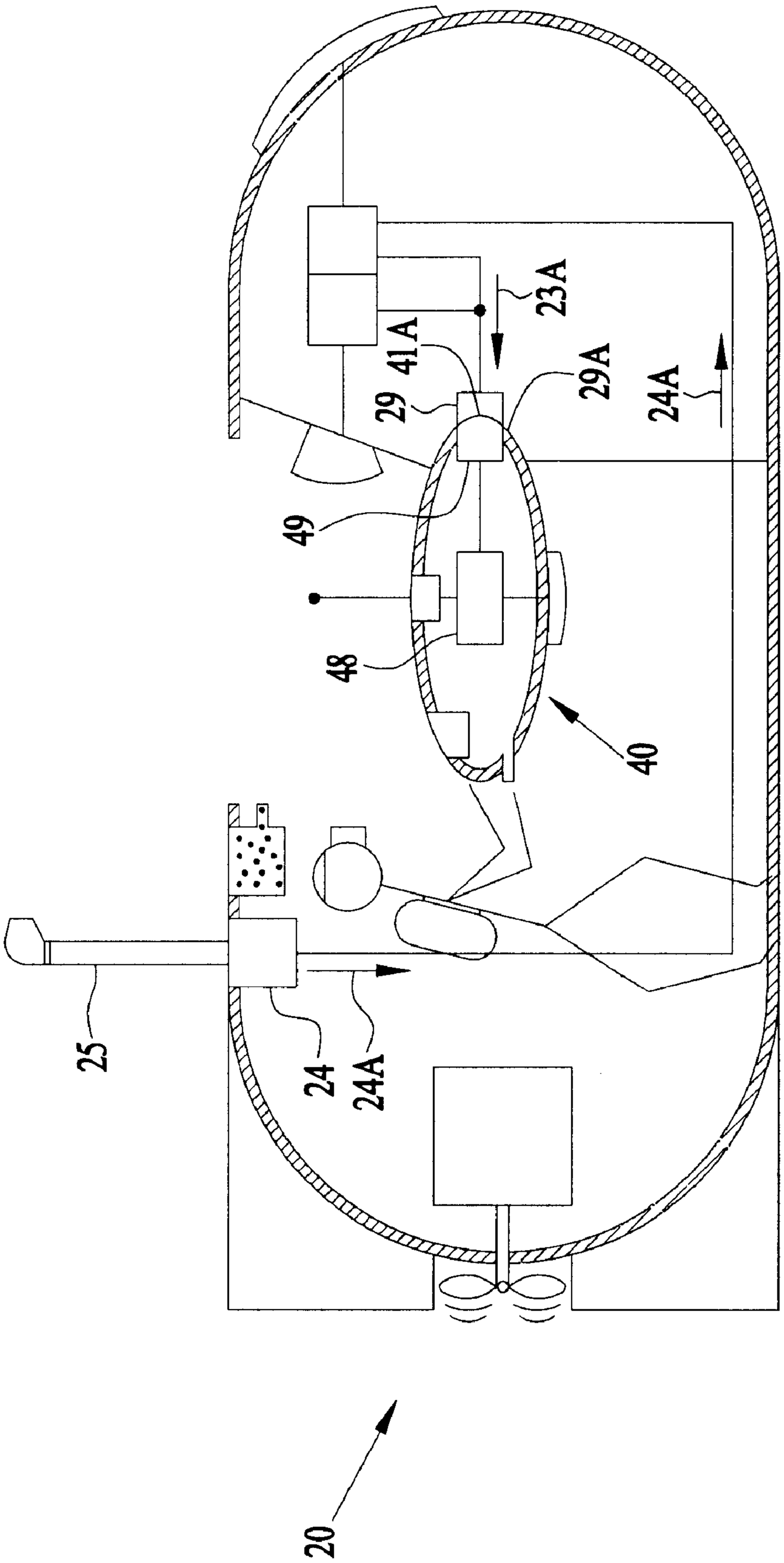

FIG. 2

EXPENABLE/RECOVERABLE VOICE AND DATA COMMUNICATIONS SYSTEM BUOY

STATEMENT OF GOVERNMENT INTEREST

BACKGROUND OF THE INVENTION

This invention relates to communications links. More particularly, this invention is to an untethered buoy carrying radio and acoustic transceivers for communications between surface and submerged assets that does not compromise the location of the data sources.

Currently, voice communications between a submerged asset such as a submarine, and surface assets such as ships or shore-based stations, are limited in range due to the inherent losses of acoustic transmissions through the water medium. If a radio buoy is used, it is connected to the submerged asset by an active electronic conductor or optical fiber tether. The transmission of gathered data from submerged sensor assets is not always implemented but is a desired capability that would also require an active tether. A tethered buoy reveals the presence and approximate position of the submerged asset. A tethered buoy also encumbers the asset, restricts its movement, and requires that the asset be equipped to deploy and recover the buoy.

Thus, in accordance with this inventive concept, a need has been recognized in the state of the art for an untethered communications buoy system for long-range, high-speed electromagnetic and acoustic transmission of data between submersibles and surface ships without compromising location of either.

OBJECTS AND SUMMARY OF THE INVENTION

An object of the invention is to provide an untethered communications buoy system bidirectionally transmitting electromagnetic and acoustic data without compromising the location of data sources.

Another object is to provide an untethered communications buoy system for long-range, high-speed data transfer between manned or unmanned submerged assets and surface assets.

Another object of the invention is to provide an untethered communications buoy system for long-range, high-speed data transfer between submerged assets and surface assets.

Another object of the invention is to provide a buoy system for long-range, high-speed voice communications and/or exchange of digital data files between submerged assets and surface assets.

Another object of the invention is to provide an untethered buoy system using radio links for long-range, high-speed data transmission of acoustic data between submerged assets and surface assets.

Another object of the invention is to provide a buoy system transmitting acoustic data over a radio communications link located remotely from its submerged source.

Another object of the invention is to provide a buoy system minimizing the risk of detection and compromise of the submerged asset while the data gathered during the mission is passed to the fleet.

These and other objects of the invention will become more readily apparent from the ensuing specification when taken in conjunction with the appended claims.

Accordingly, the present invention is to an untethered communications buoy system having an untethered buoy freely floating on the surface of water so as not to compromise the location of a submersible. The submersible has a cavity containing a first data interface member connected to a computer/data-storage that is connected to an acoustic transducer. The untethered buoy has a computer/memory module connected to a radio transceiver and acoustic transceiver. A second data interface member is connected to the computer/memory module and is mounted on a rim of the untethered buoy for fitting into the cavity and mating with the first data interface member. A ship is remotely located from the submersible and buoy and has a radio transceiver and an acoustic transceiver. Mating the first and second data interface members permits bidirectional downloading of data between the computer/data-storage and the computer/memory module.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic representation of the communications system of the invention having an untethered buoy for an acoustic link and a radio link between a submersible and surface ships to assure real-time voice/digital data communications.

FIG. **2** is a schematic representation showing loading of data from a submersible onto an untethered buoy.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. **1**, communications system **10** of the invention transmits real-time, two-way voice and/or digital data communications between a submerged asset **20** and a distant surface asset **30** of the fleet. Communications system **10** has an untethered buoy **40** to reduce the risk of detection and/or compromise of submerged asset **20** while the data gathered for a mission is transmitted to surface asset **30** without delay.

Submerged asset **20** can be a compact, manned swimmer delivery vehicle, flooded as depicted, or a larger, full-size submarine or other manned or unmanned submersible, remotely deployed sensor array, or transponder of data that is deployed in bodies of water **12**, such as an ocean. Submerged asset (hereinafter referred to as submersible) **20** can be deployed for unattended, attended, autonomous, or manned operation. A computer **21** having data storage **22** onboard submersible **20** can store data **23** from a wide variety of sources. These data sources include but are not limited to: 1.) video data signals shown as arrow **24**A from video camera **24** on periscope **25**, 2.) voice communication data signals, shown as arrow **15**A from an underwater microphone/speaker **15** near on-board diver/operator **16**, 3.) acoustic data signals **26**A reflected from objects (not shown) and received at acoustic transducer **26** from acoustic signals **26**B projected from acoustic transducer **26**, and 4.) acoustic data signals **27** relayed or transmitted from distant hydrographic or tactical data sources (not shown). Submersible **20** can remain submerged and on-station during extended missions in the hostile undersea environment.

Surface asset **30** can be one or more distant ships of the fleet or shore-based installations each having a radio antenna **32** connected to a radio transceiver **34**. Each radio transceiver **34** can transmit electromagnetic signals shown as arrow **34**A that could represent commands and other data,

and each radio transceiver **34** can receive distantly originating electromagnetic data signals. Surface asset (hereinafter referred to as ship) **30** does not reveal its position when operating in the passive, receive-mode. This enables it to initiate responsive action including transmission of electromagnetic signals **34**A without being exposed to the dangers associated with being at the location of submersible **20**. Ship **30** additionally has an acoustic transceiver **36** transmitting acoustic signals **36**A that could be commands or other information, and each acoustic transceiver **36** can receive distantly originating acoustic data signals.

Buoy **40** is intended to be expendable but under some conditions, it may be recovered for later use. Buoy **40** can be carried inside of or extends across an access hatch **28** of submersible **20** as it is transported to where it will be deployed. To deploy buoy **40**, a source of compressed gas **20**A in submersible **20** is connected to a one-way fitting **20**B in flexible outer wall, or hull **41** of buoy **40** to inflate and extend hull **41** to a rigid saucer shape containing a sealed interior **42**. Compressed gas source **20**A can be pressurized gas tanks or scuba tanks onboard for diver/operator **16**. Inflated buoy **40** is positively buoyant, and when released, or launched from submersible **20**, it freely floats to surface **14** of water **12**. Buoy **40** is not tethered to submersible **20** so that wind and ocean currents can carry buoy **40** away and separate it from submersible **20**.

In some operational scenarios, a passive lanyard **43** can extend between submersible **20** and buoy **40** to help control the launch and to retrieve buoy **40** when direct transfer of data between buoy **40** and submersible **20** is called for. When lanyard **43** is attached, however, it may be severed soon after its period of usefulness has finished preventing compromise of the location of submersible **20**.

Buoy **40** has a radio transceiver **44** connected to a radio antenna **45** extending above hull **41** for a radio communications link, and an acoustic transceiver **46** extending below hull **41** for an acoustic communications link. A battery power source **40**A and computer/memory module **48** for stored data **48**A is connected to radio transceiver **44** and acoustic transceiver **46**, and computer/memory module **48** is connected to a male data interface member **49** on rim portion **41**A at one side of hull **41**. Noting FIG. **2**, male data interface member **49** on rim portion **41**A can engage mating female data interface member **29** in a correspondingly shaped cavity **29**A in submersible **20** when operator **16** fits rim portion **41**A into correspondingly shaped cavity **29**A to bidirectionally download data between computer/data-storage **21**, **22** in submersible **20** and computer/memory module **48** in buoy **40**. Mating data interface member **49** on rim portion **41**A and data interface member **29** in correspondingly shaped cavity **29**A can be any of a number of known data connectors capable of transmitting signals underwater. The shapes of rim portion **41**A and correspondingly shaped cavity **29**A help guide and assure engagement of mating male and female data interface members **29**, **49** in the sometimes confining inside of submersible **20** and under low light conditions. Data interface members **29**, **49** could be optical connector elements that conduct optical data between them when brought within a predetermined special disposition. In this case computer/memory module **48** in buoy **40** and computer/data-storage **21**, **22** in submersible **20** would have suitable optical data converters to convert the data to and from optical form.

This downloading of data shown as arrow **23**A of data **23** in data storage **22** of submersible **20** can occur when operator **26** fits data interface members **29**, **49** together and initiates downloading of data **23** from computer/data-storage **21**, **22** of submersible **20** to computer/memory module **48** of buoy **40**, see FIG. **2**. This downloading process can be reversed when computer/memory module **48** in buoy **40** has stored data **48**A downloaded into computer/data-storage **21**, **22** of submersible **20** via data interface members **29**, **49**. Stored data **48**A in computer/memory module **48** can be, for example, of electromagnetic signals **34**A transmitted from radio transceiver/antenna **34**, **35** on ship **30** to radio transceiver/antenna **44**, **45** on buoy **40** or acoustic data signals **36**A transmitted from acoustic transducer **36** on ship **30** to acoustic transceiver **46** on buoy **40**.

Acoustic transceiver **46** on buoy **40** also can be used to download stored data **48**A from buoy **40** by transmitting stored data **48**A as projected acoustic data signals **46**A to acoustic transducer **26** on submersible **20**. Acoustic data signals **46**A from buoy **40** are received by acoustic transducer **26** that generates responsive data signals shown as arrow **26**C that are coupled to computer/data-storage **21**, **22** as data signals **23** to effect an acoustic downloading of data **48**A from buoy **40** to submersible **20**. This acoustic downloading process can be reversed by acoustically sending data signals **23**A from computer/data-storage **21**, **22** in submersible **20** as projected data signals **26**D from transducer **26**, and acoustic transceiver **46** in buoy **40** receives data signals **26**D and generates responsive data signals **46**B that are coupled to computer/memory **48** as data signals **48**A to effect an acoustic downloading of data **23**A from submersible **20** to buoy **40**.

Either of acoustic transceiver **46** or transducer **26** can transmit acoustic data signals **46**A or data signals **26**D from buoy **40** or submersible **20** at low power to acoustic transceiver **36** of ship **30** when it is in range to receive such acoustic transmissions. It may be advantageous however to send acoustic data signals **26**D at low power to buoy **40** to avoid detection, and then acoustic transceiver **46** on buoy **40** can transmit acoustic data signals **46**A at higher levels of power to ship **30** to assure reliable transmission. Sending higher power acoustic signals **46**A from buoy **40** will not give away the position of submersible **20** and could be a more covert way of sending the information when eavesdropping of electromagnetic signals is know to be more likely.

Buoy **40** can start transmitting data as electromagnetic signals shown as arrow **44**A to ship **30** as soon as buoy **40** reaches surface **14**. Optionally, buoy **40** can float on surface **14** until acoustic transmit command signal **26**D or **36**A sent from submersible **20** or ship **30** is received by acoustic transceiver **46** or electromagnetic transmit command signal **34**A sent from ship **30** is received by radio antenna **45**. Any combination of transmit protocols is possible such as: transmit when commanded, transmit until commanded to stop, transmit once unless commanded to repeat, etc.

Computer/memory module **48** in buoy **40** also could be commanded or preprogrammed for detonating an explosive charge **47** to destroy or blow a hole in flexible wall **41** or otherwise scuttle and sink buoy **40**. Detonation of charge **47** could be in response to remotely originating electromagnetic or acoustic command signals or in response to any chosen basis such as time at the surface, life of battery power source **40**A remaining, sunrise, or other hydrographical and/or tactical data.

Long messages consisting of a great number of acoustic data signals or data signals of high information content can also be passed from submersible **20** to ship **30** over the acoustic link that includes acoustic transceiver **36**, water **12** and acoustic transducer **26**. But if the time required to

complete the long message transmissions is not available or practicable, buoy **40** could be retrieved by lanyard **43** (assuming in this scenario that buoy **40** remains tethered by passive lanyard **43** to submersible **20**). The high information content signals are downloaded to buoy **40** and stored as described above, and buoy is released to float on surface **14**. Radio transceiver **44** quickly transmits electromagnetic signals **44A** having the information content of the high information content data signals to ship **30** and a short acoustic signal **46A** from acoustic transceiver **46** notifies operator **16** of submersible **30** via acoustic transceiver **26** that the radio transmission to ship **30** was complete. Submersible **20** can retrieve buoy **40** to reestablish the connection between mating data interface members **29, 49**, and any data received from ship **30** in the form of electromagnetic signals **34A** or acoustic signals **36A** can be utilized by operator/diver **16**. Buoy **40** can be deflated and retained for reuse.

Having buoy **40** of communications system **10** of the invention untethered eliminates the encumbrance otherwise created by an active. tether (electronic or optical) over which data has been transmitted between a submerged vessel and a relay buoy. The complications that the deployment and recovery of such an active tether and buoy entail also are avoided. Buoy **40** of the invention can still be recovered by way of passive tether **43** if the risk is acceptable.

Buoy **40** can be released to float and freely drift on surface **14** as submersible **20** proceeds on its way out of the release area before the transmission of data begins. The risk of detection and compromise of submersible **20** is thus minimized while data gathered during the mission is passed to the fleet without delay. Both manned and unmanned submersibles **20** could incorporate the features of this invention to employ this capability and benefit from its advantages.

Having the teachings of this invention in mind, modifications and alternate embodiments of communications system **10** may be adapted without departing from the scope of the invention. Communication system **10** of the invention provides real-time voice communications and the exchange of digital data files that are too large for acoustic transmission between a submersible **20** and ship **30** while not compromising the submersible's location. Communication system **10** of the invention does not limit the range of voice and data communications between a submersible and surface ship that might be otherwise lost due to attenuations inherent in acoustic transmissions.

The disclosed components and their arrangements as disclosed herein, all contribute to the novel features of this invention. Communications system **10** assures reliable data transfer and does not create undue danger for those gathering data from the marine environment irrespective of ambient conditions. Therefore, communications system **10**, as disclosed herein is not to be construed as limiting, but rather, is intended to be demonstrative of this inventive concept.

It should be readily understood that many modifications and variations of the present invention are possible within the purview of the claimed invention. It is to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

I claim:

1. A communications system comprising:

a submersible in water having a cavity containing a first data interface member connected to computer/data-storage for data and an acoustic transducer connected to said computer/data-storage;

an untethered buoy having a computer/memory module connected to a radio transceiver and acoustic transceiver and having a second data interface member connected to said computer/memory module and mounted on said untethered buoy for fitting into said cavity and mating with said first data interface member; and

a ship remotely located from said submersible and buoy having a radio transceiver and an acoustic transceiver.

2. The communications system of claim **1** wherein mating said first data interface member and said second data interface member permits bidirectional downloading of data between said computer/data-storage and said computer/memory module.

3. The communications system of claim **2** wherein said radio transceiver and acoustic transceiver permit transmitting downloaded data from said submersible to said ship.

4. The communications system of claim **3** wherein said radio transceiver and acoustic transceiver permit receiving data from said ship for downloading from said ship and buoy to said submersible.

5. The communications system of claim **4** wherein said untethered buoy is deployed from said submersible for freely floating on the surface of said water.

6. The communications system of claim **5** further comprising:

a video camera connected to a periscope on said submersible for creating video data signals, said video data signals being coupled to said computer/data-storage.

7. The communications system of claim **6** further comprising:

an underwater microphone/speaker providing a source of voice data signals between an on-board diver/operator in said submersible and said computer/data-storage, said voice data signals being coupled to said computer/data-storage.

8. The communications system of claim **7** wherein said data of said computer/data-storage includes acoustic data signals reflected from objects and received at said acoustic transducer from acoustic signals projected from said acoustic transducer.

9. The communications system of claim **8** wherein said data of said computer/data-interface includes acoustic data signals from distant hydrographic and tactical data sources.

10. The communication system of claim **9** wherein said data interface members are optical connector elements connecting optical data, and said computer/memory module in said buoy and said computer/data-storage in said submersible have suitable optical data converters to convert the data to and from optical form.

11. The communication system of claim **9** further comprising:

an explosive charge in said buoy for scuttling said buoy.

12. The communications system of claim **11** wherein scuttling of said buoy is in response to remotely originating command signals.

13. The communications system of claim **12** wherein scuttling of said buoy is in response to chosen hydrographical and tactical events including time at the surface, life of battery power source remaining, and sunrise.

14. The communication system of claim **9** further comprising:

a passive lanyard extending between said submersible and said buoy for controlling launch and retrieval of said buoy and to permit direct transfer of data between said buoy and said submersible.

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